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Title of the Invention: Hinge Mechanism for a Limb Protector

1. The priority claim is of Patent Number PCT/GB98/00713, filing date
2. 03/05/98 Priority date 03/05/97
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4. Related Applications:
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7. This invention relates to a hinge mechanism for a limb protector for the
8. joint of a human limb, that is a knee or elbow protector. Therefore it can
9. have related application as a knee or elbow brace.
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12. Background to the Invention:
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15. Injuries to the limbs and their joints occur for several reasons, including
16. participation in contact sports such as American football or ice hockey,
17. in individual sports such as skiing or motorcycle racing or indeed any
18. active sport. In addition injuries to limbs and their joints occur in active
19. occupations such as armed forces, or in any type of accident.
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23. After an injury occurs, it is often desirable to either slightly restrict the
24. movement of the limb or the joint, for example by elastic support, or
25. severely restrict movement of the limb or joint by ridged splints, or
26. ridged braces that restrict the degree of movement of the limb or joint,
27. for example by hinged knee or elbow braces (de-rotational braces).
28. Such braces which are available to prevent twisting of a knee or elbow
29. can be worn during activities such as skiing and can have preventative
30. as well as protective effect. Such hinged braces are by their very nature
31. restrictive of movement and permit only forward bending of the knee or
32. elbow. Other braces are available for sports such as American football
33. which protects the knee against side impact or frontal impact but also
34. restrict movement (prophylactic or preventative braces). Dynamic
35. braces are also available with eccentrically placed hinges to provide

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36. protection to torn ligaments. The present invention relates to rigid
37. hinged braces.

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40. Related art:

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42. WO

43. 94/18916 discloses a variety of hinged braces to be worn for the
44. protection or support of a damaged or potentially damageable joint. The
45. braces disclosed have, when applied to a knee joint, respective upper
46. and lower rigid supports which engage the leg above and below the
47. knee and which are hinged one to the other to allow bending of the joint.
48. Because of the way the joints of a human being are physically
49. constructed the bending of a joint can occur around any point within a
50. given area covering that joint when that joint is viewed from the side, or
51. in a direction substantially parallel to the axis of rotation of the joint.
52. The exact point about which the joint rotates is dependent upon the
53. construction of the joint, any injuries sustained by the joint or the limb
54. either side of the joint, or the amount by which the limb, and hence the
55. joint has already been bent. When for example the joint being rotated
56. is the knee, the points about which rotation may occur may be either
57. side of the cartilage that separates the tibia and fibula bones on the one
58. side, and the femur on the other side of the knee joint or on both sides of
59. the cartilage. Accordingly, to hinge the upper and lower supports
60. together about a simple pivot is unsatisfactory. Instead, in preferred
61. constructions as shown in Figures 5 and 16 of WO 94/18916, each is
62. pivoted to an intermediate member and the two intermediate members
63. are pivoted to one another. This allows the axis of rotation to vary
64. relative to the joints, e.g. When moving from standing vertically to
65. bending one's knees.

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68. The constructions shown in WO94/18916 are cumbersome, complex to
69. assemble, and require the manufacture of a plurality of telescopic shells
70. which must slide over one another easily, but which must be sufficiently
71. rigid and impact-resistant (as such braces are often worn during contact
72. sport play to enable play to occur, but reducing the risk of further injury
73. to a recovering limb) to ensure that such movement can be maintained
74. without jamming. These criteria are not easy to meet.

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76. I have now found that a much more effective and robust hinging
77. mechanism can be provided which maintains the flexibility of
78. movement provided by the constructions shown in WO 94/18916, but
79. which does not incur its disadvantages. In particular, it may enable easy
80. assembly and disassembly and is very resistant to mechanical damage.

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83. British Government Sponsored Research Grant:

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86. The development of this invention was funded by the United Kingdom
87. Grant: Supports for Products Under Research grant, this grant was
88. known as the SPUR grant.

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91. Brief Summary of the Invention:

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94. According to the present invention there is provided a hinge mechanism
95. for a limb protector including first and second supports each adapted to
96. engage a part of a limb in either side of an articulated joint, the hinge
97. mechanism being pivotally connected to both supports, and wherein the
98. hinge mechanism comprises a base plate, an arm pivotally rotatable
99. against the plate about an axis substantially perpendicular thereto and
100. located to one end of the arm, and means (by way of connecting
101. screws) for connecting the support members pivotally to the other end
102. of the arm and to the plate, all of these three axes of rotation of the
103. pivotal connections being substantially parallel, and wherein associated
104. with each of the three pivotal connections are means for restricting the
105. relative degree of rotation of the respective two members to a defined
106. amount.

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109. Preferably, the arm is mounted rotationally on a circular boss on the
110. plate and the plate has stop means formed thereon restricting the
111. angular rotation of the arm, e.g., to a maximum of 60 degrees

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114. Preferably, the angular rotation of each support member relative to the
115. end of the arm or the base plate respectively is restricted by the passage
116. of a stud or post along an arcuate slot centred on the pivot axis. The
117. post is conveniently on the base or arm and the arcuate slot in the
118. support member. The extent of the arcuate slot may vary, but is
119. commonly in the range of 50 degrees to 110 degrees.

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122. By hinging of the supports together using a hinge mechanism according
123. to the present invention, with all three pivots having a restricted degree
124. of rotation, the degree of rotation of each of the first, second and third
125. pivotal connections may be set to predetermine the maximum
126. translational and rotational movement between the bones of the joint
127. around which the brace is to be fixed. This may be achieved by
128. providing slots of lengths corresponding to the maximum likely desired
129. degree of pivotal movement, e.g. 60 and 90 degrees and then limiting
130. the degree of rotation of either or both slots by inserting into the arcuate
131. slot spacers or other means of preventing rotation, so that the relevant
132. studs or posts may move only along a portion of that slot.

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135. The degree of rotation available to the arm may be limited by locating
136. the arm in a recessed portion of the plate which is bounded by radial
137. walls e.g. inclined at 60 degree to one another. To limit the degree of
138. rotation further spacers or other means of preventing rotation may be
139. fixed within the recess. In place of a recess with walls, the amount of
140. rotation of the arm may be defined by studs mounted on the plate.

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143. The hinge mechanism of the present invention may be made of any
144. suitable material, preferably aluminium alloy, though, if desired,
145. suitable engineering plastics materials may be used. The support
146. members are conventionally made of ridged material. In order to avoid
147. over stressing such materials where they are connected to the hinge
148. mechanism, reinforcements, e.g. of metal, may be installed. In
149. particular, it is found useful to reinforce the edges of the arcuate slots
150. with a metal plate or liner.

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153. In use, each limb protector or brace would have a hinge mechanism
154. according to the present invention on either side of the joint around
155. which the brace was placed.
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158. The hinge of the present invention may be employed on all currently
159. known types of kneebrace once suitable modification has been made to
160. those knee braces. In particular, the present invention is of value
161. applied to braces as described in WO 94/18916, with the arrangement
162. as described above replacing the front plates of the hinged brace
163. described therein.
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166. None of the prior art of records discloses, teach or suggests a limb
167. protector with a hinge mechanism comprising a pivotal connection of
168. a first support to a base plate, a first end of an arm pivotally rotating
169. against the base plate about an axis perpendicular to the base plate, a
170. pivotal connection of the second end of the arm to a second support, the
171. second support having an arcuate slot and the arm having a post for
172. engaging the slot to limit the pivotal movement of the second support
173. relative to the arm and such that the connections are a means for
174. restricting the degree of angular rotation of the hinge mechanism.
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177. Castillo discloses in Figures 7-12 an orthosis with two supports and a
178. hinge mechanism, the hinge mechanism comprising a base plate, an
179. arm (103) pivotally rotatable against the plate about an axis
180. perpendicular to the plate a means for connecting one support pivotally
181. to other end of the arm, and a pivotal connection of the other support to
182. the base plate. In addition, Castillo discloses in Figures 9 and 12 the
183. rotation of each support is restricted by the passage of a post (103)
184. along a slot located on the base plate. However, Castillo does not
185. disclose that the slot is arcuate and located on the support member.
186. One of ordinary skill in the art would not have known to modify
187. Castillo to overcome these deficiencies. Note that Castillo discloses in
188. column 7, lines 16-25 one or more spacers (107, 109) inserted into
189. the slot to limit the degree of rotation.

190. Rogers (5,107,824), Hauser (2,632,440), Lamb (Re.33,621),
191. Biedermann (5,490,822), and Aaserude (4,699,129) disclose the state of
192. the art of knee hinges with slots and recesses to limit motion. Pansiera
193. (4,802,467) and Hauser disclose bosses used in a bicentric knee hinge.
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196. The invention is illustrated by way of example with reference to the
197. accompanying drawings in which:
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200. Figure 1 shows a perspective view of the knee brace incorporating a
201. hinge mechanism according to the present invention, and
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203. Figure 2 shows a detail of the brace of Figure 1 in exploded view.
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205. Referring to Figure 1, the knee brace which is illustrated lying on its
206. side and from the back as shown in the drawings, consist basically of
207. upper and lower hollow shell members 1 and 2 respectively shaped to
208. accommodate the thigh and calf of the wearer. Members 1 and 2 are
209. joined by hinge mechanism 3 and 4, described in more detail below,
210. and may be held on the respective parts of the legs by means of hard
211. moulded semi-cylindrical portions 5 and 6. Projecting from the ends
212. of portions 5 and 6 are locating tabs and straps which fit into
213. corresponding apertures in members 1 and 2 via appropriate snap action
214. catches enabling each to be pushed towards the member 1 and 2
215. respectively to fit snugly around the thigh or calf respectively.
216. Substantially the whole of the interior of members 1 and 2, 5 and 6 is
217. lined with a cushioning foam for comfort. Fitted to the interior of each
218. of the members 1 and 2 are some short metal rods which are
219. substantially vertical when the brace is worn with the wearer standing
220. upright. These are obscured in the drawing by double-sided burr
221. fastener straps 10, 11, 12 and 13. Straps 12 and 13 are relatively short
222. and one end of each terminates in an elongate plastics ring 15 and 16
223. respectively through which the free end of the rather longer straps 10
224. and 11 may be passed and then folded back on itself to tension each
225. strap round the rear of the lower thigh and upper calf respectively. The
226. central portions of the longer strap 10 and 11 may be fabrics faced than
227. faced with burr fastener material, for greater comfort.

228. Hollow shell member 2 is constructed in two parts, the left hand one of
229. which as shown in the drawing has an annular outward facing groove
230. 20 and the other portion of which to the right in Figure 1 has and
231. annular inward facing rib 21. Rib 21 can slide in the annular grove to a
232. certain extent, thus allowing a limited degree of swivelling between the
233. portion of the brace which is attached to the thigh and the portion which
234. is attached to the calf. This swivel feature is described in more detail in
235. specification WO94/18916. The right hand portion of member 2 is held
236. captive in the left hand portion by means of a pair of squat T-section
237. bosses which pass through two short slots 25 and 26 located in the base
238. of groove 20.

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241. In accordance with the invention, members 1 and 2 are held together by
242. two hinged mechanisms 3 and 4. Each of hinge mechanism 3 and 4
243. consists of a base plate 40, 41 respectively which is pivotally attached
244. directly to member 1 and which has mounted on it a swivellable arm to
245. the free end of which is pivotally attached member 2.

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248. The detailed construction of the hinge mechanism 4 is shown in Figure
249. 2. The construction of hinge mechanism 3 is identical save for being a
250. mirror image of hinge mechanism 4. Referring now to Figure 2, this
251. shows an exploded view of the hinge mechanism with the two members
252. 1 and 2 detached from the base plate 41 and the arm contained therein,
253. for clarity of explanation.

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256. Base plate 41 has two threaded bosses on its surface facing hinge
257. mechanism 3. One of these, denoted 50 in Figure 2, acts as the pivotal
258. connection between base plate 41 and member 1. For this purpose, a
259. lockable threaded stud 51 may be passed through an aperture 52 in
260. member 1 and screwed into boss 50 which is internally threaded. As
261. that occurs, an upstanding arcuate tab 54 enters in to an arcuate slot 55
262. in the material of member 1, slot 55 being centred on aperture 52. Not
263. shown in the drawing is a metal reinforcement which is moulded into
264. the exterior of member 1 and which has an aperture registered with
265. aperture 52 and arcuate slot registered with arcuate slot 55. When

266. member 1 is accordingly assembled on to base plate 41, it can pivot
267. relative thereto, but only to the extent allowed by the travel of tab 54 in
268. slot 55.

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271. If it is desired to restrict the range of rotation of member 1 relative to
272. base plate 41, a suitable stop member may be inserted at one or both
273. ends of slot 55.

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276. Mounted on base plate 41 is a swivel arm 60. The left hand end of this
277. arm as seen in Figure 2 is of ring shape and fitted round a further
278. threaded post formed integrally with base plate 41 and held in place by
279. a screw- in stud 61. The circular left hand end of arm 60 is located in a
280. generally circular recess 62 in base plate 41, this recess is a
281. continuation of the circular wall of which is formed in two sections as
282. shown in 68, one of radius (this has a shoulder recessed as shown in 64)
283. only slightly greater than the radius of the ring on the left hand arm of
284. arm 60 and the other of enlarged radius, the two part cylindrical walls
285. of recess 62 abutting at a shoulder 64 which lies in a radial plane
286. relative to the hidden threaded stud about which arm 60 may swivel. On
287. one side of the generally ring-shaped end of arm 60 is a partial annular
288. flange 66 which, when its end as shown on the left in Figure 2 abuts
289. shoulders 64, limits the clockwise rotation of arm 60. The anti-
290. clockwise rotation is limited by the right hand end of arm 60 as shown
291. in Figure 2 coming to abut an internal wall 68 formed in base member
292. 41. Thus, arm 60 may swivel through a defined angle, which may be
293. reduced by inserting packing members against shoulder 64 or wall 68 if
294. it is desired to do so. (It can also be seen in 68 that the radial wall which
295. are part of wall 68 are lined at an angle to one another.

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298. Member 2 is pivotally connected to the right hand end of arm 60 by
299. means of a threaded stud 70 which passes through an aperture 71 in
300. member 2 and into a threaded post 72 on the end of arm 60. Arm 60 is
301. formed with an upstanding tab 74 which, when member 2 is assembled
302. on to the arm 60, passes through an arcuate slot 76 in member 2. As
303. with member 1, where of aperture 71 and arcuate slot 76 is prevented
304. by a metal plate set into the side of member 2, not visible in Figure 2.
305. Again, the extent of rotation permitted between arm 60 and member 2

306. may be reduced by inserting stop members into one or both ends of
307. arcuate slot 76.

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310. The outer periphery of base plate 41 may be contoured so that its inner
311. face lies closely against the exterior faces of members 1 and 2 thus
312. reducing the ingress of dirt or other contamination when the knee brace
313. is worn. The hinge mechanism 3 and 4 permit natural flexure of the
314. wearer's leg with the three pivotal connections, the pivot axes of which
315. correspond to the threaded shafts of studs 51, 61 and 70, enabling a
316. natural and comfortable movement to occur. Excessive flexure of the
317. joint, beyond what the wearer's medical
318. or physiotherapist advisors would recommend, may be prevented by
319. restricting the range of angular movement of one, two or all three of
320. these pivotal connections by the use of packing members as indicated
321. above.